Level 2 PGE Clear-Sky Detection Products

The clear-sky detection products described here are still under development and should be ignored by the user. They are generated on different spatial resolution scales by various processing subsystems within the AIRS L2 PGE, including the VIS/NIR, the IR pre-retrieval, and final cloud clearing stages. Some products are specific to particular observation conditions such as day or night, land or ocean. The following pages provide description on these products which are divided according to their spatial resolution, AIRS footprints or AMSU FOVs. Abbreviation are:

D=Day; N=Night; O=Ocean; L=Land; LW=LongWave; SW=ShortWave

AIRS Footprint Resolution

The infrared shortwave and longwave clear FOV detection discriminants are located in the L2 Support Product:

Discriminant	represents	valid over
tsurf_diff_4um	SW predicted SST - forecast SST	N/O
tsurf_diff_11um	LW predicted SST - forecast SST	D&N/O

Note: the predicted SST is obtained by regression. The regression coefficients are based on simulated radiances and thus on the version of AIRS forward RTA employed to calculate them.

Discriminant	represents	valid over
spatial_coh_4um	Std Dev. of SW BT over the 3X3 FOVs	N/O
spatial_coh_11um	Std Dev. of tsurf_diff_11um over the 3X3 FOVs	D & N/O

Note: all elements of spatial_coh_4um are set to the same value
Note: all elements of spatial_coh_11um are set to the same value

The infrared shortwave and longwave clear FOV flags that are set in the Level 2 retrieval PGE based on these discriminants are located in the Standard Product:

Flag	value if clear	value if cloudy	valid over
clear_flag_4um	1	0	N/O
clear_flag_11um	1	0	D & N/O

Thresholds are still under development. The thresholds employed in V3.0.8.0 L2 PGE are more inclusive than those being used at JPL as of this writing. If the user wishes to use different thresholds, data selection can be based on tests applied to the discriminants rather than by simple filtering via the flags.

Level 2 Clear Flags Documentation

The V3.0.8.0 Level 2 PGE thresholds which must be satisfied for an FOV to be declared clear are:

regime	tests satisfied if FOV declared clear
shortwave (4um)	(tsurf_diff_4um > -1.0) and (spatial_coh_4um < 0.3)
longwave (11um)	(tsurf_diff_11um > -1.0) and (spatial_coh_11um < 0.5)

The more restrictive thresholds being used at JPL are:

regime	tests satisfied if FOV declared clear
shortwave (4um)	(tsurf_diff_4um > -0.5) and (spatial_coh_4um < 0.2)
longwave (11um)	(tsurf_diff_11um > -0.5) and (spatial_coh_11um < 0.3)

Additional infrared discriminants are available in the Level 2 Support Product, but they still under development and the user is urged to ignore them at this time. Two sets control the state of **fov_clear_flag**, one over ocean and one over land. A 10 word array per AIRS footprint is set aside for discriminants over ocean:

fov_ocean_cc_test controlling fov_clear_flag over ocean		
word	**represents**	**valid over**
1	TB(965.32 cm^{-1}) brightness temperature, K	O
2	forecast SST – TB(2616 cm^{-1}), K	N/O
3	TB(2616 cm^{-1}) – TB(predicted from 8um), K	N/O
4	TB(2616 cm^{-1}) – TB(predicted from 11um), K	N/O
5	forecast SST – predicted SST (8um & 11um), K	O
6	forecast SST, K	Any
7	spare	
8	spare	
9	spare	
10	spare	

The dimension of fov_ocean_cc_test is [10,3,3,30,45]. Over ocean, **fov_clear_flag** is set equal to unity (signifying clear) by the L2 retrieval PGE if the following conditions are all met:

fov_ocean_cc_test(1) < 268 K
fov_ocean_cc_test(2) > 0.8 K
fov_ocean_cc_test(3) > 0.0 K
fov_ocean_cc_test(4) > 0.0 K
abs(fov_ocean_cc_test(5)) < 0.2 K
fov_ocean_cc_test(6) > 271 K

Over land, four separate discriminants control **fov_clear_flag**:

Discriminants controlling fov_clear_flag over land	
Discriminant	**represents**
fov_sswr_fr_lw_resid	forecast SST – predicted SST (8um & 11um), K
fov_swlw_resid	TB(2668.22 cm^{-1}) – TB(900.56 cm^{-1}), K
fov_rad_resid	TB (predicted from AMSU ch #1->#7) – TB(2390.8 cm^{-1}), K
prelim_rad_dev	measure of partial coherence among 3x3 array fov_rad_resid, RMS in radiance units

The value of **prelim_rad_dev** is thresholded to set **prelim_clear_flag** for the AMSU FOV:

If (prelim_rad_dev < 3.0 x NEdR for 2390.8 cm^{-1}) then prelim_clear_flag = 1

Where NEdR is the noise equivalent change in radiance for that channel and the threshold, 3xNEdR is equal to 0.0026 milliwattts/m^2/cm^{-1}/steradian.

Over land, **fov_clear_flag** is set equal to unity (signifying clear) by the L2 retrieval PGE if the following conditions are all met:

fov_psw_fr_lw_resid < 0.0 K
fov_psst_resid < 0.2 K
fov_swlw_resid < 0.0 K
fov_rad_resid < 0.8 K
prelim_clear_flag = 1

Important Note: The thresholds for the discriminants used to set fov_clear_flag were generated before launch of the instrument and the tests are still under development. Do not use these discriminants or fov_clear_flag over ocean or land.

The Vis/NIR clear FOV detection discriminants are located in the L2 Support Product:

Discriminant	represents	valid over
CldFrcVis	Integer % of visible pixels in AIRS footprint identified as cloudy; there are 72 such pixels, so granularity is 1.4%	D/L&O
cldHgtMapVis	Array of visible pixels in AIRS footprint identified as containing low clouds (-1=>unknown; 0=> no low cloud; 1=>low cloud) a low cloud is beneath the 800 mb level	D/L&O

These discriminants control the setting of AMSU FOV resolution visible flags, **vis_clear**, **vis_cloudy** and **vis_low_cloud** (see below).

AMSU FOV Resolution

The AMSU FOV resolution discriminant, **prelim_rad_dev**, and the flag it controls, **prelim_clear_flag**, have already been described above in the discussion about **fov_clear_flag**. These are found in the Level 2 Support Product. The last AMSU FOV resolution IR clear flag, **clear_flag**, is found in both the Level 2 Standard Product and the Level 2 Support Product. It is intended to become the ultimate clear AMSU FOV flag determined via the combined clear detection algorithms. It wil be set to a value of unity for clear FOVs. This flag is also under development and should be ignored by the user.

Clear_flag will be set equal to unity (i.e., clear AMSU FOV):

If:

The number of cloud-cleared channels with sufficient scene contrast is ≤ 4

or

The number of cloud-cleared channels with sufficient contrast is ≥ 4 and
$(25 < \lambda_{max} < 125$ for ocean) or $(25 < \lambda_{max} < 225$ for land) and
$\Sigma R_{cc}(\nu) - R_{avg}(\nu) < 0.1$ for cloud-cleared channels between 800 – 900 cm^{-1}

where

λ_{max} is the largest eigenvalue of $[\Delta R' N^{-1} \Delta R]$ from the Level 2 cloud clearing
$R_{cc}(\nu)$ are the reconstructed clear column radiances
$R_{avg}(\nu)$ is the averaged radiance of the 3x3 AIRS footprints in the AMSU FOV

The AMSU FOV resolution visible clear flags are:

Flag	explanation	valid over
vis_clear	True (=1) if at least 97.2% (=70 of 72 pixels) of each AIRS footprint within the AMSU FOV is clear; False (=0) if not; set by threshold on **CldFrcVis**; value of –1 or 255 signifies indeterminant	D/O&L
vis_cloudy	True (=1) if at least 79.2% (=57 of 72 pixels) of each AIRS footprint within the AMSU FOV is cloudy; False(=0) if not; set by threshold on **CldFrcVis**; value of –1 or 255 signifies indeterminant	D/O&L
vis_low_cloud	True (=1) if at least 79.2% (=57 of 72 pixels) of each AIRS footprint within the AMSU FOV is low cloud; False(=0) if not; set by threshold on **cldHgtMapVis**; value of –1 or 255 signifies indeterminant	D/O&L

Comparison of AIRS L2 Cloud-Cleared Radiance with Simulated L1B Clear Radiance for 9/6/2002

The mean spectra and the bias and standard deviation of the difference between Level 2 Cloud-Cleared radiance and the corresponding simulated L1B radiance from ECMWF forecast are shown below. The spatial coverage is all oceanic FOVs within the latitude range, |lat| < 40°. Observation included in the calculation must have passed a chosen clear test and successfully passed all stages of the Level 2 retrieval (RetQAFlag equal to 0). The effect of scan angle is not differentiated, i.e. all angles included. Additional discriminators such as binned retrieved cloud fractions can be applied to establish whether there exist a relationship between the bias and standard deviation statistics and the discriminators used.

Figure 1 shows the mean of 131 **night ocean** brightness temperature spectra(top) which are identified as clear for the 3X3 AIRS FOVs by the **final** clear flag, with retrieved cloud fraction between 0.0 and 0.01**.** The bias(purple) and standard deviation(green) of the difference between cloud cleared radiance and the ECMWF simulated clear radiance are shown in the bottom panel.

Figure 2 shows the mean of 154 **day ocean** brightness temperature spectra(top) which are identified as clear for the 3X3 AIRS FOVs by the **final** clear flag, with retrieved cloud fraction between 0.0 and 0.01**.** The bias(purple) and standard deviation(green) of the difference between cloud cleared radiance and the ECMWF simulated clear radiance are shown in the bottom panel.

The bias and standard deviation are ~ -1K and 1K, respectively in both 8-12um and 4um window regions. The cold bias may results from warm SST in the model, by roughly 0.5 K at night. The large bias in the 9.6um O_3 band is the result of inconsistent ECMWF ozone profiles used in the simulation. The 15um CO_2 stratospheric channel warm bias is caused by the cold stratosphere of ECMWF forecast. The Non-LTE effect which only affects the 4um stratospheric channels during the day results in exceedingly large bias values in Fig. 2.

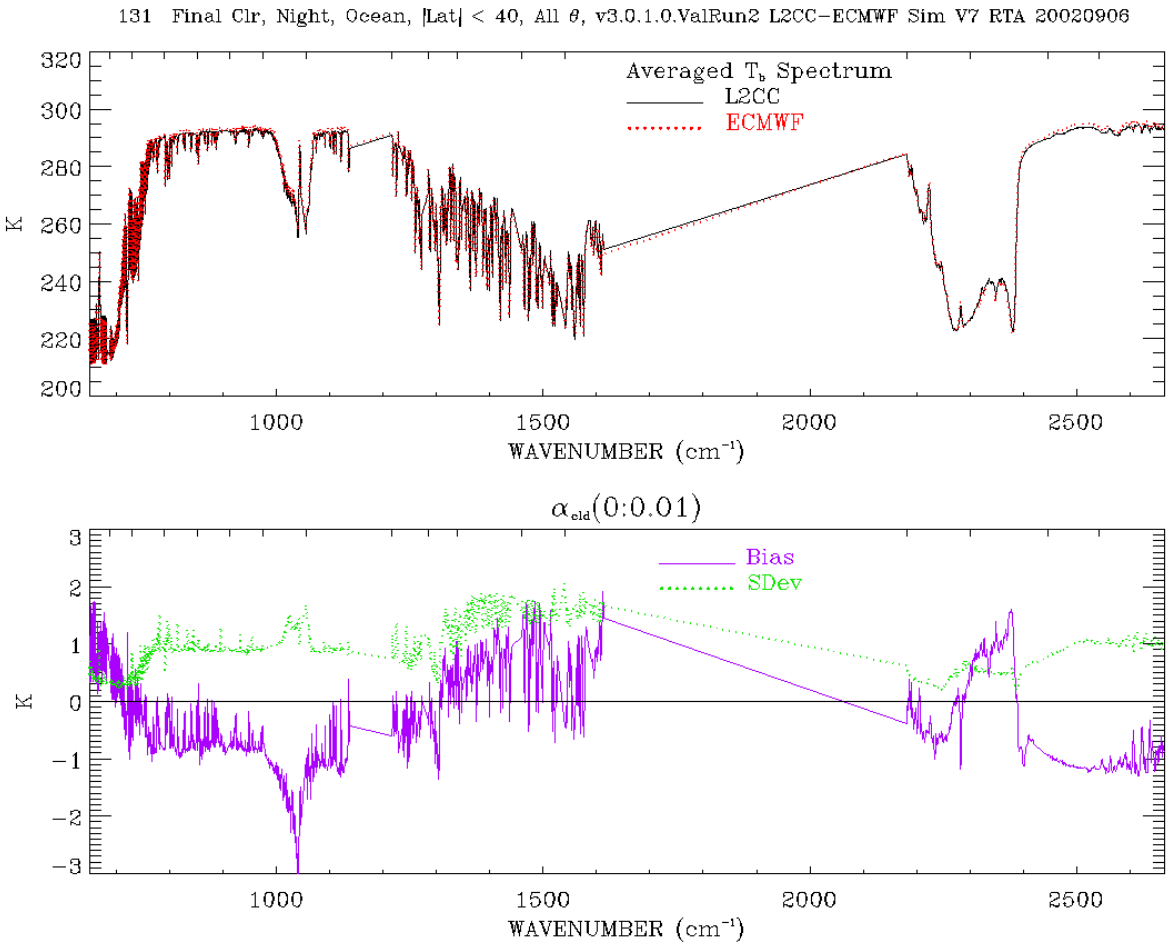

Figure 1

The mean of 131 **night ocean** brightness temperature spectra which are identified as clear for the 3X3 AIRS FOVs by the **final** clear flag, with retrieved cloud fraction between 0.0 and 0.01(top)**.** The bias and standard deviation of the difference between cloud cleared radiance and the ECMWF simulated clear radiance (bottom)

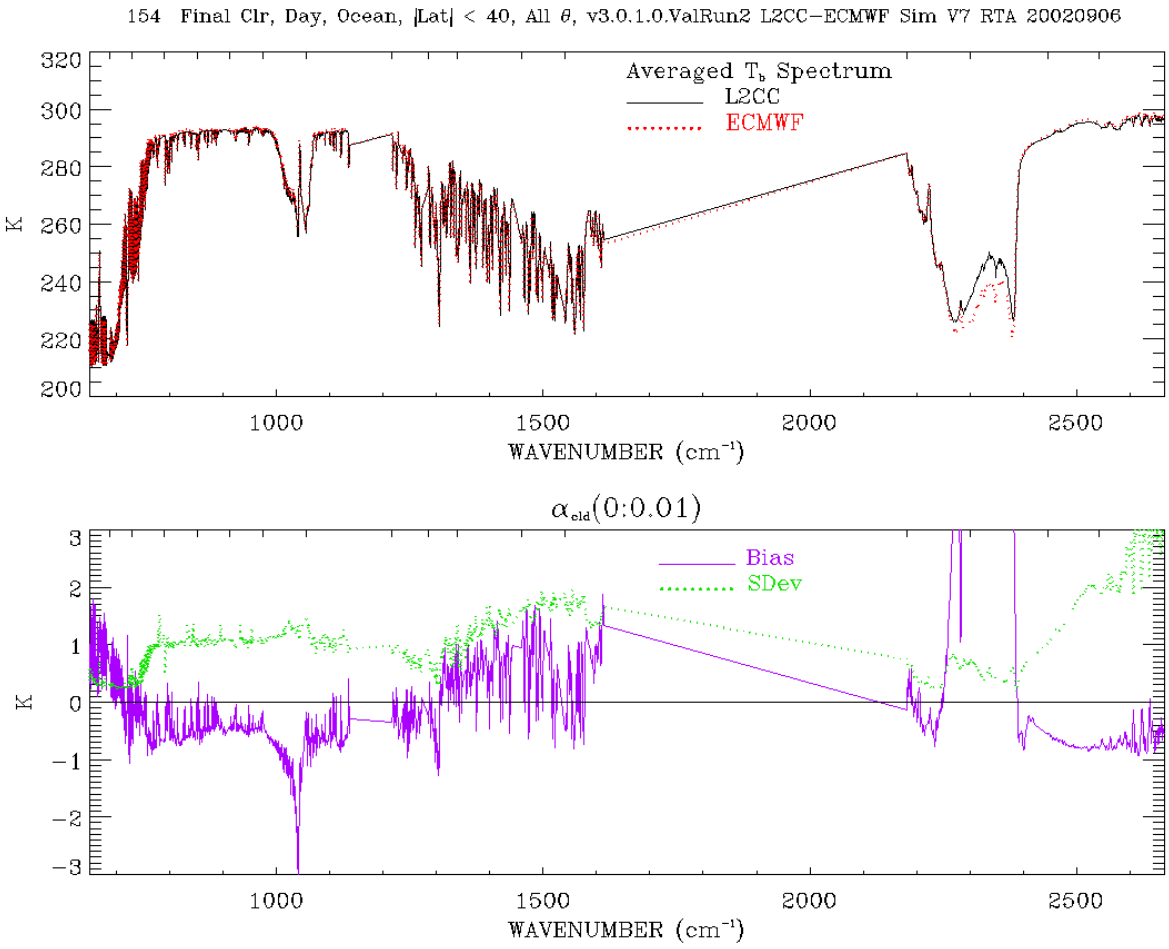

Figure 2

The mean of 154 **day ocean** brightness temperature spectra which are identified as clear for the 3X3 AIRS FOVs by the **final** clear flag, with retrieved cloud fraction between 0.0 and 0.01(top)**.** The bias and standard deviation of the 131 pair of brightness temperature spectra (bottom)**.**